SURFACE EFFECT SHIP ENHANCEMENTS

CROSS REFERENCE TO OTHER APPLICATIONS

This application is a continuation-in-part to United States applications Ser. No. 10/274,654 filed October 21, 2002 now abandoned; Ser. No. 10/286,712 filed November 1, 2002; and Ser. No. 10/337,490 filed January 7, 2003.

BACKGROUND OF THE INVENTION

Marine Surface Effect Ships (SES) in their generic form have a upper hull that is rather flat on its underside with downward extending asymmetrical catamaran sidehull portions either side. These asymmetrical sidehull portions are connected transversely fore and aft by flexible seals. The boundary of the space thus formed is pressurized with air supplied by powered blowers to thereby form a deep air layer between the hull and the water's surface. This results in a vessel that has little water contact and is therefore quite efficient at high speeds in calm water.

Major shortcomings of the generic SES are that: 1) The wide barn door effect of the flexible bow seal contributes to a drastic increase in resistance and poor sea keeping characteristics when moderate to high seas are encountered, 2) The flexible bow seal allows waves to enter and upset the stability of the supporting gas cushion that is really a huge gas spring. This results in a very uncomfortable 2-4 cycle per second oscillation that is commonly known as the SES "cobblestone" ride effect, and 3) The large full span flexible bow and stern seals are rather expensive and high maintenance.

Applicant has successfully addressed the shortcomings of the generic SES with his patented SEACOASTER Surface Effect CATamaran (SECAT) inventions. SEACOASTER has fine entry bows on long and slender sidehulls with gas cushion

recesses built into their undersides. Blower pressurized air is supplied to the two recesses thereby essentially forming two parallel surface effect ships mounted to a common hull structure. The shortcomings of the generic SES are avoided since there are no high cost and maintenance flexible seals and there is no gas cushion between the sidehulls. The fine entry bows of the SEACOASTER's sidehulls provide an excellent ride in rough seas and there is no "cobblestone" ride as is experienced with the generic SES.

However, compared to a generic SES of similar size, the SEACOASTER inventive hull has two shortcomings: 1) It has about 30 percent less air cushion surface area and hence requires a higher cushion pressure due to the non-pressurized area between its sidehulls and 2) It has more wetted area since it has four sidewalls, one on each side of each of its air cushions, while the generic SES has only two sidewalls. Even with these relatively minor shortcomings, the SEACOASTER is proving to be a very successful concept.

The instant invention proposed herein addresses the minor shortcomings of the SEACOASTER concept while still designing out the major shortcomings of the generic SES. This will be understood upon review of the following sections.

SUMMARY OF THE INVENTION

The primary object of the instant invention is to provide a very efficient and sea kindly marine surface effect ship that is partially supported by artificially pressurized gas cushion(s).

It is a further object of the invention that it include port and starboard sidehulls and bow members.

It is related object of the invention that a moveable seal member(s) be disposed in a general transverse direction to thereby form a portion of a seal for the artificially pressurized gas cushion(s).

It is a directly related object of the invention that the moveable seal member(s) extend between inboard portions of the port and starboard bow members.

It is a directly related object of the invention that the moveable seal members are moveable in relation to a hull of the enhanced surface effect ship.

It is another object of the invention that water contacting portions of the port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at high speed in a calm sea at a bow up trim angle of one and one-half degrees, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member by at least ten percent of a waterline length of the enhanced surface effect ship.

A directly related object of the invention is that water contacting portions of said port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at high speed in a calm sea at a bow up trim angle of one and one-half degrees, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member by at least fifteen percent of a waterline length of the enhanced surface effect ship.

A further related object of the invention is that the port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at

high speed in a calm sea at a bow up trim angle of one and one-half degrees, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member by at least twenty percent of a waterline length of the enhanced surface effect ship.

Yet still another related object of the invention is that water contacting portions of said port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at high speed in a calm sea at a bow up trim angle of one and one-half degrees, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member by at least twenty-five percent of a waterline length of the enhanced surface effect ship.

Another object of the invention is that forward water contacting portions of said port and starboard bow members can further comprise artificially pressurized gas cushion portions disposed in their undersides.

A directly related object of the invention is that the artificially pressurized gas cushion portions disposed in the undersides of the port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at high speed in a calm sea, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member.

A directly related object of the invention is that it be defined as running at a bow up trim angle.

Another directly related object of the invention is that the bow up trim angle be less than five degrees with an optimum angle being less than two and one half degrees.

Yet another related object of the invention is that the artificially pressurized gas cushion portions disposed in the undersides of the port and starboard bow members extend, as seen when the enhanced surface effect ship is moving forward at high speed in a calm sea, forward of an average of longitudinal positions, as seen in longitudinal vertical planes of the enhanced surface effect ship, of forward water contacting portions of a moveable gas seal member by at least five percent of a waterline length of the enhanced surface effect ship.

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Another directly related object of the invention is that the bow up trim angle be less than five degrees with an optimum angle being less than two and one half degrees.

Still another object of the invention is that the gas cushion portions disposed in the undersides of the port and starboard bow members diverge either side of vertical sidehull longitudinal planes going aft from their forward portions.

A directly related object of the invention is that the vertical longitudinal planes are vertical longitudinal centerline planes of the port and starboard sidehulls.

A further object of the invention is that water contacting portions of said moveable gas seal member disposed between the port and starboard sidehulls extends over less than twenty percent of an overall width of the enhanced surface effect ship proximal the moveable gas seal member.

A related object of the invention is that water contacting portions of said moveable gas seal member disposed between the port and starboard bow members extends over less than twenty-five percent of an overall width of the enhanced surface effect ship proximal the moveable gas seal member.

Yet another related object of the invention is that water contacting portions of said moveable gas seal member disposed between the port and starboard bow members extends over less than thirty percent of an overall width of the enhanced surface effect ship proximal the moveable gas seal member.

Still another related object of the invention is that water contacting portions of said moveable gas seal member disposed between the port and starboard bow members extends over less than thirty-five percent of an overall width of the enhanced surface effect ship proximal the moveable gas seal member.

Another important object of the invention is that inboard portions of the port and starboard sidehulls are truncated over a portion of their length aft of their bow portions.

A related object of the invention is that truncated aft extending portions of said port and starboard sidehulls extend downward from an upper portion of a gas cushion recess to thereby form, at least partially, fluid fences that at least partially separate portions of the artificially pressurized gas cushion.

A directly related object of the invention is that, when the enhanced surface effect ship is moving forward at high speed in a calm sea, said fluid fences of said port and starboard sidehulls are not in contact with a water surface over a majority of their length.

A directly related object of the invention is that it be defined as running at a bow up trim angle.

Another directly related object of the invention is that the bow up trim angle be less than five degrees with an optimum angle being less than two and one half degrees.

A further object of the invention is that a gas cushion aft seal, as seen in a vertical transverse plane of the enhanced surface effect ship, comprises at least two inverted-V shaped portions.

It is a related object of the invention that the stern seal may further comprise a moveable seal element.

A further object of the invention is that the port and starboard bow members diverge either side of vertical sidehull longitudinal planes going aft from forward portions of their bows.

A directly related object of the invention is that the vertical sidehull longitudinal planes are vertical sidehull centerline planes of the port and starboard sidehulls.

A further object of the invention is that forward water contacting portions of said port and starboard bow members diverge either side of their water contacting bow portions such that their measured inboard and outboard divergence either side of their water contacting bow portions is numerically within fifty percent of each other.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 presents an underside 3D perspective of a preferred embodiment of the instant invention enhanced surface effect ship.

Fig. 2 is an underside plan view of the enhanced surface effect ship of Fig. 1.

Fig. 3 is a topside plan view of the enhanced surface effect ship of Fig. 1 with the main deck and some portions of the secondary decks removed to show machinery arrangements.

Fig. 4 gives a bow view of the preferred embodiment of the instant invention enhanced surface effect ship.

Fig. 5 is a stern view of the instant invention enhanced surface effect ship.

Fig. 6 presents an external side view of the instant invention surface effect ship.

Fig. 7 is a cross-sectional view, as taken through line 6-6 of Fig. 2, that shows a gas cushion pressurizing blower and shape of a gas cushion.

Fig. 8 presents a cross-sectional view, as taken through line 7-7 of Fig. 2. This shows portions of a fluid fence that at least partially separates portions of the gas cushion and one of the propulsors.

Fig. 9 gives a centerline cross-section, as taken through line 9-9 of Fig. 2, that shows a section of a forward moveable seal that is disposed between the sidehulls.

Fig. 10 presents a half-breadth cross section, as taken through line 10-10 of Fig. 2, that shows a section of hull forward of the moveable seal member disposed between the bow members.

Fig. 11 is a half-breadth cross section, as taken through line 11-11 of Fig. 2, that shows part of an air cushion recess, blower discharge, and moveable seal elements.

Fig. 12 gives another half-breadth cross section, as taken through line 12-12 of Fig. 2, that illustrates a typical midship section. Note the fluid fence that is vertically oriented here.

Fig. 13 presents a half-breadth cross section, as taken through line 12-12 of Fig. 2, that indicates the shape of the gas cushion stern seal proximal the stern. Note that the propulsor drive shaft is intersected here.

Fig. 14 presents a 3D rendering of a simplified version of the instant invention enhanced surface effect ship that is less the fluid fences plus the gas cushions do not extend forward into the port and starboard bow members. Note also that the moveable seal elements are staggered here in an optional arrangement of the moveable seal installation.

DETAILED DESCRIPTION

Fig. 1 presents an underside 3D perspective of the enhanced surface effect ship 37 to the instant invention. Items to note are forward extending port bow member 49 and starboard bow 50. These bow members extend forward of a moveable seal member 38. In this particular example the moveable seal member 38 comprises five individual flexible elements that are held in shape by the pressurized air in the gas cushion 48. Artificially

pressurized gas is supplied to the gas cushion through gas discharge openings 39. Air or gas enters through air openings 36 that may be in the sides of the vessel as shown here.

The pressurized gas is retained in the gas cushion 48 by sidehulls 42, bow members 49, 50, moveable seal member 38, gas cushion recess top 51, stern seal 44 and, of course, the water surface. A set of fluid fences 41 are used here to restrict movement of fluids from one portion of the gas cushion 48 to another. It is desirable that these fluid fences 41 do not make water contact during high speed operation in order to reduce wetted area frictional resistance. Thrust is provided by propulsors 31. Some optional propulsor water inlets 40 are shown here for illustrative purposes.

Fig. 2 gives a bottom plan view of the instant invention enhanced surface effect ship 37. Items shown are similar to those given in Fig. 1 with the addition of gas flow arrows 47 that have been added. .

Fig. 3 presents a topside plan view with the primary deck and some secondary deck portions removed. This illustrates installation of some of the critical machinery elements. Included are a propulsor 31, propulsor drive shaft 35, and propulsor engine 33. A typical blower 32 is driven by blower drive engine 34.

Fig. 4 presents a bow view of the instant invention enhanced surface effect ship 37. Some items shown include a vertical centerline plane 45 and sidehull vertical centerline planes 46 of the vessel. It is important to note the width of the lower water contacting portion of the moveable seal 38. It is about 25 percent of the total width of the instant invention enhanced surface effect ship 37 proximal the moveable seal 38 here which is in a desired range. Some definitions of the desired limits on percentage of moveable seal 38 width for the instant invention enhanced surface effect ship are given in

a preceding section titled SUMMARY OF THE INVENTION. The percentage of total vessel width of the moveable bow seal of a generic SES is more like 80 percent. The very wide moveable bow seal of the generic SES makes for an effect like pushing a barn door sideways over the surface of the water. While not a problem in calm water, the barn door effect of the generic SES's moveable bow seal results in tremendous increases in resistance and a severe degradation in ride quality as sea state increases.

Fig. 5 shows a stern view that illustrates preferred locations of propulsors 31.

Fig. 6 gives a profile view of the instant invention enhanced surface effect ship 37. Note the waterlines 30 shown fore and aft here. In order to make definitions clear, it is stated here that the claims are drawn based on the instant invention surface effect ship 37 running forward at high speed in calm seas with the air cushion(s) pressurized. It is normal for best performance that the vessel will be running at a bow up trim angle. Bow up trim angles would normally be less than five degrees with an optimum angle being less than two and one half degrees. High speed herein is defined as 15 knots or greater.

Fig. 7 gives a cross sectional view, as taken through line 7-7 of Fig. 2, that shows where the waterlines 30 intersect the port sidehull bow 49 and stern seal 44. This is the condition when traveling forward at high speed in calm seas. The powered blower 32 is shown in cross section here.

Fig. 8 shows another cross sectional view, as taken through line 8-8 of Fig. 2, illustrating hull shape proximal an inboard portion of a sidehull 42. Note the depth of the fluid fence 41 that restricts fluid flow between portions of the gas cushion 48. The optional fluid fence 41 is intended to be made as high as possible to reduce its water contact with either the water surface inside the gas cushion 48 or from water spray. The

fluid fence 41 is valuable because it reduces the spreading of any pressure perturbations in the gas in the gas cushion 48. The fluid fences 41 also contribute to the structural integrity of the hull since they provide long and deep longitudinal structural members.

Fig. 9 is a cross sectional view, as taken through line 9-9 of Fig. 2, that shows a section made through a vertical centerline plane of the instant invention enhanced surface effect ship 37. It shows part of the moveable seal member 38 disposed between the port and starboard bow members. Note how far the water contacting portions a bow member 49 extends forward of the water contacting portion of the moveable seal 38. This is an important consideration to the instant invention enhanced surface effect ship 37 since it: 1) Provides pitch stability forward of the moveable seal, 2) Allows the sidehulls to develop full width where the moveable seal is located, and 3) Allows the sidehulls to develop near vertical inboard surfaces proximal the moveable seal. Some definitions of the desired ranges of extension of water contacting portions of the bow members forward of the water contacting portions of the moveable seal are given in a preceding section titled SUMMARY OF THE INVENTION.

Fig. 10 presents a half-breadth cross section, as taken through line 10-10 of Fig. 2, that illustrates the relatively fine entry of one of the bow members upstream of the moveable seal member.

Fig. 11 gives a half-breadth cross section, as taken through line 11-11 of Fig. 2, that shows working of the flexible seal member 38 against a side of a bow member. This also illustrates location of the blower discharge 39 in this section. The waterline 30 is proximal keels of the bow member here since the blower is in operation and the gas cushion 48 pressurized. Note that in all of the figures presented that the gas cushion 48 is

pressurized and the enhanced surface effect ship 37 is moving forward at high speed in a calm sea. For purposes of this application, high speed is defined as being speeds of 15 knots or more.

Fig. 12 presents a half-breadth cross section, as taken through line 12-12 of Fig. 2, that is of a typical midship section of the preferred embodiment of the instant invention. Note the waterline 30 inside of the gas cushion 48 and how the fluid fence 41 does not make contact with the waterline 30 during this illustration of calm water operation.

Fig. 13 is a half-breach cross section, as taken though line 13-13 of Fig. 2, that shows a preferred embodiment transverse vertical plane cross section just forward of the transom. The propulsor drive shaft 35 is intersected in this cross section.

Fig. 14 presents a generally simplified version of the instant invention enhanced surface effect ship 37 in an underside 3D perspective similar to that presented in Fig. 1. In this Fig. 14 instance, the port and starboard bow members do not include portions of an air cushion. This lack of air cushions under the bow members will result in a rougher ride than the air cushioned bows presented in Fig. 1 but would work otherwise. Further, the fluid fences have been eliminated here to simplify the design. Also, the moveable bow seal elements have been staggered which is a simple option and a moveable seal element 52 has been added as part of the stern seal. It is to be noted also that any variation of moveable seal design including flexible fabric, hinged rigid elements, or the like may be used either forward or aft. The variations shown in Fig. 14 are well within the scope and spirit of the instant invention and are just simple easy to incorporate options.

While the invention has been described in connection with a preferred and several alternative embodiments, it will be understood that there is no intention to thereby limit the invention. On the contrary, there is intended to be covered all alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims, which are the sole definition of the invention.